TFL 8 inventory audit

Introduction

An inventory is conducted by the licensee of each Tree Farm Licence (TFL) in British Columbia every 10 to 50 years, using standards and procedures that are approved by the Ministry of Forests. Regular updates are undertaken to reflect changes in the timber volume due to growth and to depletions from harvesting and natural causes.

This report presents the results of an inventory audit performed within the TFL 8, which is located in the Boundary Forest District in the south central interior of BC. It is comprised of two separate units: Block 1 in the Boundary Creek area, north of Greenwood, and Block 2 in the Trapping Creek and Carmi Creek drainages, north of Beaverdell. The TFL is held by Pope & Talbot Ltd. and is administered by the Boundary Forest District within the Nelson Forest Region.

Purpose of the audit and application of the results

It is often asked, "How accurate is the current inventory?" To answer this important question, the Ministry of Forests has developed an inventory audit methodology specifically designed to test the overall accuracy of estimates of the total standing volume in each timber supply area.

This inventory audit methodology entails sampling three primary components of the inventory: mature forests, immature forests, and non-forest areas.

The objective of the inventory audit program is to help identify TFLs or TSAs where the forest inventory needs attention. Enough samples are taken to ensure statistically reliable results for the TFL as a whole.

The amount of data collected, however, is not sufficient to make statistically reliable conclusions about specific strata within the TFL. For example, any overall differences, highlighted by the audit, could result from problems: with one tree species, from part of the land base (such as high elevation rather than lower elevation areas), from one age group of forest stands, or from a combination of these and other factors. As a consequence, general audit results cannot be used to adjust information for timber harvesting purposes since the audited area represents only a small portion of the total forested area in the TFL.

The audits provide information that may be useful to the Chief Forester when determining the allowable annual cut—offering a general assessment of the uncertainty associated with mature timber volumes, immature site index, and the non-forest classification. However, the audit results cannot justifiably be used to make specific adjustments to growth and yield and other information used in timber supply analyses and allowable annual cut determinations.

Methods

Current inventory

There are 35 TFLs in British Columbia, varying in size from approximately 8,500 hectares to 1 million hectares. Inventories of each TFL are conducted through a multistage process. Although the methodology varies within each TFL, all standards must be approved by the Ministry of Forests. New standards currently under development will ensure a consistent minimum standard for all TFLs. Generally, polygons are first delineated from 1:15 000-scale aerial photographs. Photo-interpretation is then used to produce data on a number of attributes for each polygon. These attributes include species composition, stand height, age, and crown closure. Timber volume is then estimated indirectly using the photo-interpreted variables and an empirical yield model. Other approaches to volume estimation, approved by the Ministry of Forests, may also be used.

To keep estimates current, inventories are regularly updated to account for forest growth and for depletions due to harvesting, fire, and the impact of insects and disease damage. Empirical yield models, such as the Ministry of Forests Variable Density Yield Prediction (VDYP) computer model, are used to update the inventory for forest growth. Field visitation, satellite imagery, and aerial photographs may be used to update the inventory for depletions.

Inventory audit procedures

The inventory audit tests three components of the current inventory. The first component is the mature forested areas (forest stands older than 60 years). The inventory audit tests the accuracy of the mature timber volume. The second component tested is immature stands (younger than 60 years but older than the silvicultural classification of free growing). The audit tests the accuracy of the site growth potential (site index) assignment for these stands. The third component tested is the area classified as non-forest in the inventory, which includes areas such as lakes, gravel pits, and alpine meadows. The audit tests the accuracy of the photo-interpreted classification for this component.

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Mature component assessment criteria

To test the mature component of the inventory, the existing inventory's estimate of the mean mature volume per hectare for the TFL (the inventory volume), is compared with a new estimate of the mean mature volume per hectare obtained from the audit samples (*the audit volume*). In most TFLs the inventory volume is assessed from base yield curves derived from the VDYP yield model.

The difference between these two estimates is called the total bias. A test is conducted on this bias to determine if it is statistically significant. This test establishes whether there are detectable differences between the audit volume estimate and the inventory volume estimate, for the total forested area of the TFL.

If the total bias is found to be statistically significant, further analyses are conducted to determine if the specific source of bias within the inventory is one of the following:

- *classification bias*: This is caused by incorrectly estimating the polygon attributes; or
- *model bias*: This is caused by poor prediction from the yield model, which was developed for large areas of the province and was not designed for specific management units.

In most TFLs the analysis used to determine the source of bias uses an estimate of the mean mature volume per hectare for the TFL called the ground attribute volume. This is calculated from audit sample attributes (stocking class and stand table estimates of species composition and stocking, and ground-based averages of top height and age), along with crown closure taken from the original map label, using the yield prediction model. The difference between the ground attribute volume estimate and the audit volume estimate approximates the bias associated with the yield model. The difference between the audit volume estimate and the inventory volume estimate not accounted for by the model bias approximates the bias associated with the inventory classification attributes. Once the source is identified, further analyses may be done on the inventory classification attributes or the yield model itself.

Immature component assessment criteria

Accuracy of the inventory classification for immature stands is tested by examining the site index assignment. Since the immature forest stand site index provides an estimate of site productivity, its accuracy affects the projection of long-term harvest levels.

Data gathered is examined to determine how closely the audit and inventory site indices match for individual samples, and to explore potential trends.

Non-forest component assessment criteria

The audit test for the non-forest component of the inventory assesses the accuracy of the non-forest classification assignment. An air photo interpreter certified by the Ministry of Forests compares the non-forest inventory classification to a suitably-scaled forest cover aerial photograph. Classification accuracy is rated using a point scoring scheme to determine an overall accuracy percentage. The acceptance criteria for this test is 85% or higher.

TFL 8 audit sampling procedures

The TFL 8 sample used updated maps based on the most recent inventory. A list of all polygons identified on the maps was produced and sorted on a number of stand characteristics (site quality, age, and species group). Polygons were systematically selected from this list by a process designed to produce a representative sample of the TFL.

For the mature forested component of the inventory audit, a random sample of 40 forested polygons from the total forested area in the TFL was selected for sampling.

Up to 4 full-measure prism plots and 5 count plots were established within each of the 40 sample polygons. The plots were located systematically, using a square grid and a random start point. The grid interval varied with polygon size. To reduce sample costs for large or irregular polygons, a portion of the polygon was randomly selected for ground sampling. A total of about 160 full-measure and 200 count plots were established. Field data collection and compilation followed Ministry of Forests cruising and cruise compilation procedures. The objective was to obtain audit volumes that were comparable (in terms of utilization standards and merchantability definitions) to the inventory volumes produced from the VDYP model.

In the case of TFL 8, the VDYP system produces net merchantable volume per hectare defined as stem volume inside bark of all live trees excluding a 10-cm diameter inside-bark top, a 30-cm-high stump, and decay (as estimated from Ministry loss factors). Dead potential and veteran trees are not included in the VDYP estimates. The volume is calculated for a utilization standard defined as all live trees of 12.5+ cm dbh. When considering the audit results, it should be noted that there are some differences between the utilization standards applied in the audit and those used operationally.

The audit volume estimates were then compared to the inventory volume estimates (from VDYP) to test the validity of the current inventory. A paired sample t-test was used to test for significant differences. The precision of the inventory volume estimates—how well each inventory volume estimate corresponds to the audit volume estimate on a sample-by-sample basis—was assessed by measuring the statistical correlation. The data was then post-stratified to detect trends related to the operable and inoperable forested land base distribution of the sampled polygons.

From the immature forested component, a random sample of 20 polygons was selected for sampling. Up to 9

inventory ground calls were established within each of the 20 sample polygons. The plots were located systematically, using a square grid and a random start point, similar to the mature volume component. A total of about 180 ground calls were established and data collection followed the standard Ministry of Forests inventory ground call procedures.

To audit the non-forest component, a random sample of 30 non-forest polygons was selected. Standard Ministry of Forests inventory air photo classification techniques were used to compare the 30 non-forest polygon classification assignments to corresponding air photos checks.

Inventory audit results

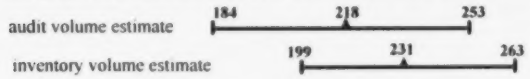
Analysis of mature volumes

Overall results of the inventory audit for mature volume in the total forested area of the TFL 8 are summarized at the 12.5+ cm dbh utilization limit in Table 1.

TABLE 1. Statistics for the audit volume and inventory volume estimates at 12.5+ cm dbh utilization (net decay), TFL 8

	Audit vol. Estimate	Inventory vol. estimate
Number of samples	40	40
Mean (m^3/ha)	218	231
Coefficient of variation (%)	50	43
Standard error	17.09	15.73
Sampling error (%)	15.8	13.8
95% confidence interval	184–253	199–263
Correlation coefficient	r = 0.625	
Ratio of means (audit/inventory):	0.95	

Bar graph representation of 95% confidence intervals (in m^3/ha):



The correlation coefficient of 0.625 for the audit and inventory estimates indicates a good relationship among the individual samples in this stratum. There is a 13 m^3/ha difference between the mean inventory estimate for mature volume (218 m^3/ha) and the audit estimate (231 m^3/ha). A paired-sample *t*-test determined that, for the mature component of the total forested area of the TFL, this difference is not statistically significant 19 times out of 20. The 95% confidence interval for the mean paired difference is –42 to +16 m^3/ha. Since there is no statistical difference between the two estimates, the ground attribute volume was not calculated.

In the timber supply process, yield curves from each polygon are aggregated by various methods into a yield curve for each analysis unit, and these analysis unit yield curves are then used to predict volume. To examine this process, volumes derived from the analysis unit yield curves were assigned to each of the audit samples. A paired-sample t-test showed that there was no significant difference between the mean analysis unit estimate and the audit estimate of mature volume.

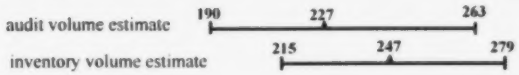
Analysis of operable and inoperable volumes

To provide audit results more likely to be applicable to the timber supply planning process, an approximation was made of the forested areas considered currently available for timber harvesting (operable areas). The audit results were post-stratified based on this approximation. Results of the inventory audit for samples in the operable forested areas in the TFL 8 are given in Table 2.

TABLE 2. Statistics for the audit volume and inventory volume at 12.5+ cm dbh utilization (net decay), operable forested areas, TFL 8

	Operable Audit volume estimate	Operable Inventory volume estimate
Number of samples	35	35
Mean (m^3/ha)	227	247
Coefficient of variation (%)	47	38
Standard error	17.97	15.78
Sampling error (%)	16.1	13.0
95% confidence interval	190-263	215-279
Correlation coefficient	r = 0.580	
Ratio of means (audit/inventory):	0.92	

Bar graph representation of 95% confidence intervals (in m^3/ha):



For the 35 samples located within the operable forested area, the mean audit volume is 227 m^3/ha and mean inventory volume is 247 m^3/ha. The difference of 20 m^3/ha between the two estimates is not statistically significant 19 times out of 20.

There were only 5 samples that were located within the inoperable forested area. The sample size is too small to allow any meaningful comparisons to be made. Because of the high variability and restrictive nature of conclusions associated with small sample size, volume estimates from inoperable forested areas are not shown.

Analysis of immature inventory classification

Out of the 20 stands sampled in the field, top height information was not available for two stands. Of the remaining 18 stands sampled in the field, the inventory correctly identified site index within ±3 m of the audit site index for 6 stands. The inventory site index was more than

3 m lower than the audit site index for 6 stands, and more than 3 m higher for 6 stands.

Analysis of non-forest inventory classification

Thirty stands classified as non-forest were assessed for accuracy of the inventory. The resulting score was 76%, which does not meet the provincial minimum standard of 85%.

Discussion and conclusions

The objective of the inventory audit in the TFL 8 was to assess the overall accuracy of the current inventory. The mature, immature, and non-forest components were tested.

Audit results for the mature component of the inventory for the TFL 8 suggest that the inventory is statistically acceptable. Subsequent analysis of post-stratified data also shows a similar level of acceptability in the operable forested area .

Audit results for the immature component of the inventory suggest an acceptable level of accuracy for site index assignment in young stands.

The audit assessment of the non-forest classification in this TFL indicates that it did not meet provincial standards. Three of the 30 polygons checked should have been classified as productive land rather than non-productive land.

Glossary

accuracy: A measure of how close an estimate is to the true value.

allowable annual cut: The rate of timber harvesting specified for an area of land.

analysis unit: The basic building blocks around which inventory data and other information are organized for use in forest planning models, typically involving specific tree species or type groups that are further defined by site class, geographic location or similarity of management regimes.

bias: The quality of a measurement device or procedures that tends to result in a systematic misrepresentation of what is being measured.

coefficient of variation: A relative measure of variation within a population, calculated as the ratio between the standard deviation and the mean value.

confidence interval: The range of values within which the population parameter is expected to lie.

confidence level: The estimated probability that a population parameter lies within a given confidence interval.

correlation coefficient: A measure of the relationship between two variables. A value of 0 for the correlation coefficient indicates a random relationship, whereas a value of ±1 indicates a perfect positive or negative linear correspondence.

dead potential trees: Standing or down dead timber which is estimated to contain at least 50% of its original gross volume in sound wood.

diameter at breast height (dbh): The stem diameter (outside-bark) of a tree measured at breast height (1.3 metres above the point of germination) to the nearest millimetre.

field visitations: Ground-level field procedures designed to provide physical verification of polygon inventory attributes.

free-growing (crop): A crop of healthy trees of a commercially valuable species, the growth of which is not impeded by competition from plants, shrubs, or other trees.

inoperable lands: Lands that are unsuited for timber production now and in the foreseeable future because of their topography, inaccessible location, low value of timber stands, or designation for uses incompatible with timber production.

mean: The average value of a set of observations.

polygon: A portion of land area, delineated on mid-scale aerial photographs, of "like" or uniform land cover type.

pre-inventory assessments: Inventory activities to evaluate the existing forest inventory as a basis for deciding whether to re-inventory or update the current inventory, and to document the existing inventory, maps, and photos to support the execution of the reinventory or update if required.

public sustained yield units (PSYU): A portion of a TSA; an area of Crown land, usually a natural topographic unit determined by drainage areas, managed for sustained yield by the Crown through the Ministry of Forests. It includes all Crown lands within the currently established boundaries of the unit and excludes federal lands, provincial parks, experimental forest reserves, gazetted watersheds and tree farm licenses.

ratio estimate: The ratio between two different estimates.

representative: The quality of a sample having the same characteristics as the population from which it is selected.

sampling: The process of selecting observations.

sampling error: The error attributed to sampling procedures.

significant difference: The results of a statistical test comparing either two or more estimates, or an estimate to a fixed value. If the difference is too large to be attributed to chance, the difference is said to be statistically significant.

site index: An expression of the forest site quality of a stand, at a specified age, based either on the site height, or on

the top height, which is a more objective measure.

standard error: An expression of the absolute variability of an estimate.

standard deviation: A measure of the variation of the population.

timber supply analysis: An assessment of future timber supplies over long planning horizons (more than 200 years) by using timber supply models for different scenarios identified in the planning process.

timber supply area (TSA): An area defined by an established pattern of wood flow from management units to the primary timber-using industries.

tree farm license (TFL): Privately managed Sustained Yield Units; designed to enable owners of Crown-granted forest lands and old temporary tenures or the timber licenses which replace them, to combine these with enough unencumbered Crown land to form self-contained sustained yield management units.

variable density yield prediction (VDYP) model: An empirical yield-prediction system for natural stands based on data collected in temporary inventory sample plots (TSPs) and natural, permanent growth sample plots (PSPs). VDYP predicts volume (net decay) and diameters at four utilization levels using stand height, age, and density. The aerial approach uses crown closure as the density measure.

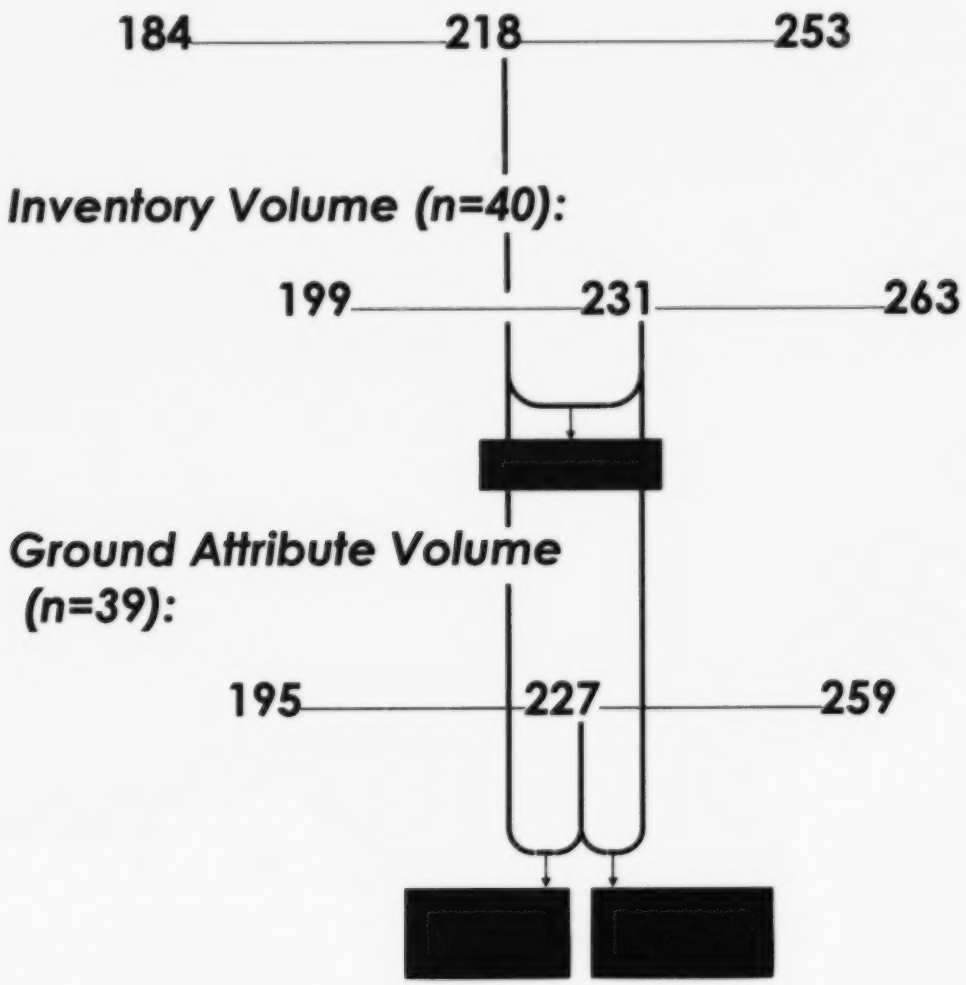
veteran trees: Mature living trees which are remnants of an older stand.

For more information

For more information or to obtain other inventory audit reports, contact: Director, Resources Inventory Branch, 722 Johnson Street, Victoria, BC, Canada V8W 3E7, Phone 250-387-1314, fax 250-387-5999, or visit our web site at http://www.for.gov.bc.ca/resinv/

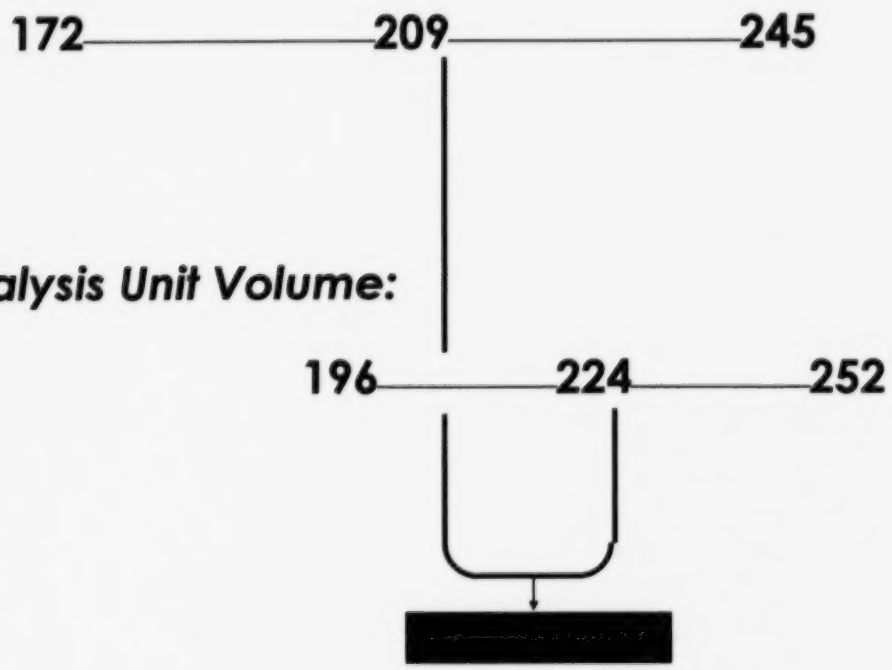
January 1999

Inventory Audit Results :
Overview TFL 8
May, 1998



*Audit Volume *(n=35):*

(TC 1,2 - DWB)



* Utilization: 12.5+cm dbh for Pl leading, 17.5+cm dbh for other species leading; tree class 1&2; net DWB. Analysis unit volumes provided by Sterling Wood.

Audit Volume (Kozak) vs. Inventory Volume (Predicted in VDYP) (n=40)

1. Average Volumes/ha and Confidence Interval @ 95% *(Utilization level : Tree Class 1,2; net merch. less decay; 12.5cm+ dbh)*

184——218——253 Audit Volume (15.8% sampling error)

199——231——263 Inventory Volume (map label attributes predicted in VDYP) (13.8% sampling error)

2. Ratio Analysis : Ratio of Means @95%

$R = \frac{\text{average audit volume}}{\text{average inventory volume}} = 0.95$

1.0 ↓

0.82——0.95——1.07

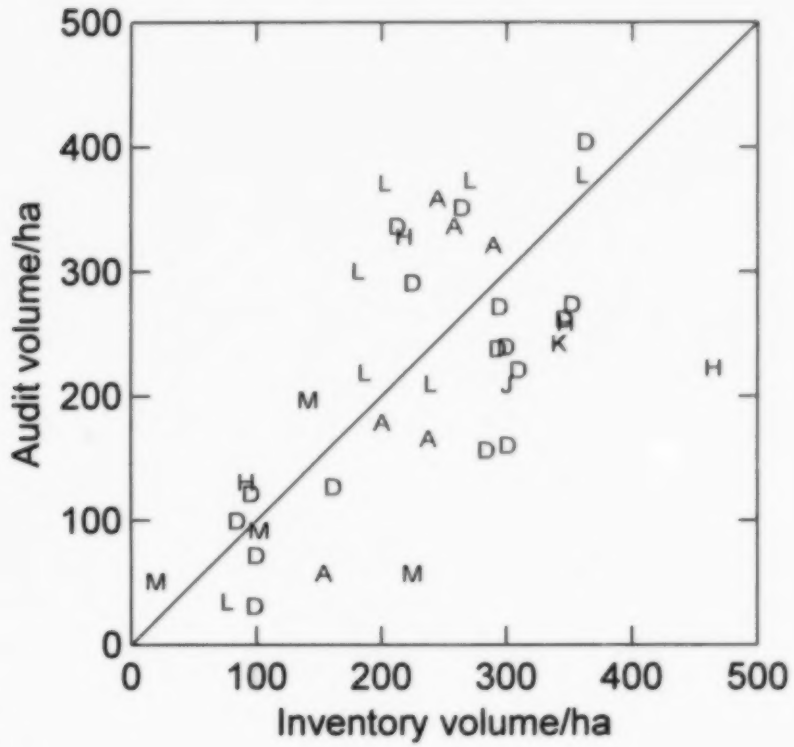
* *Since 1.0 is within the interval, the ratio indicates that there is no significant difference between the audit volume and the inventory volume.*

3. Paired T Test @ 95% (α=0.05) for all sample polygons
mean difference = -12.685 m^3/ha
p - value for mean difference = 0.379
**since p-value > α, the difference is not significant*

4. Paired T Test @ 95% for all sample polygons by map label GTG
There were no significant differences within any of the GTGs.

5. Correlation @ 95% (α=0.05) for all samples
Correlation co-efficient r = 0.625
p-value for correlation co-efficient < 0.001
.: correlation is significant

TFL 8 Inventory Audit:
Audit Volume vs. Inventory Volume (by GTG)
(Tree Class 1 & 2, less decay, 12.5cm+ dbh)



Letter symbols correspond to map label GTG's as follows:

A	*Fd, Fd Decid*	J	*SF, SH (and SC), SB*
B	*FdCw and FdYc, FdH, FdS*	K	*SPl, SDecid*
C	*Fd Pl, Fd Py, Py*	L	*Pl or Pa*
D	*FdL, Pw, LFd, L*	M	*PlFd, PlPy, PlL, PlPw, PlS, PlB, PlH, PlCw, PlYc*
H	*B, BH, BS*		

Audit Volume (Kozak) vs. Ground Attribute Volume (Predicted in VDYP): *"VDYP model" bias (n=39*)*

1. Average Volumes/ha and Confidence Interval @ 95% *(Utilization level : Tree Class 1,2; net merch. less decay; 12.5cm+ dbh)*

188 ——— 223 ——— 257 Audit Volume (15.4% sampling error)

195 ——— 227 ——— 259 Ground Attribute Volume (predicted in VDYP) (14.2% sampling error)

2. Ratio Analysis : Ratio of Means @95%

$$R = \frac{\text{average audit volume}}{\text{average ground attribute volume predicted in VDYP}} = 0.98$$

1.0

↓

0.87 ——— 0.98 ——— 1.09

* *Since 1.0 is within the interval, the ratio indicates that there is no significant difference between the audit volume and the ground attribute volume.*

3. Paired T Test @ 95% ($\alpha = 0.05$) for all sample polygons
   mean difference = -4.431 m^3/ha
   p - value for mean difference = 0.715
   **since p - value > α, the difference is not significant*

4. Paired T Test @ 95% for all sample polygons by map label GTG
   There was a significant difference within GTG M.
   (for GTG M: mean difference = -56.03 m^3/ha; p-value = 0.043; n=3)

5. Correlation @95%($\alpha = 0.05$) for all samples
   Correlation co-efficient r = 0.734
   p - value for correlation co-efficient < 0.001
   ∴ correlation is significant

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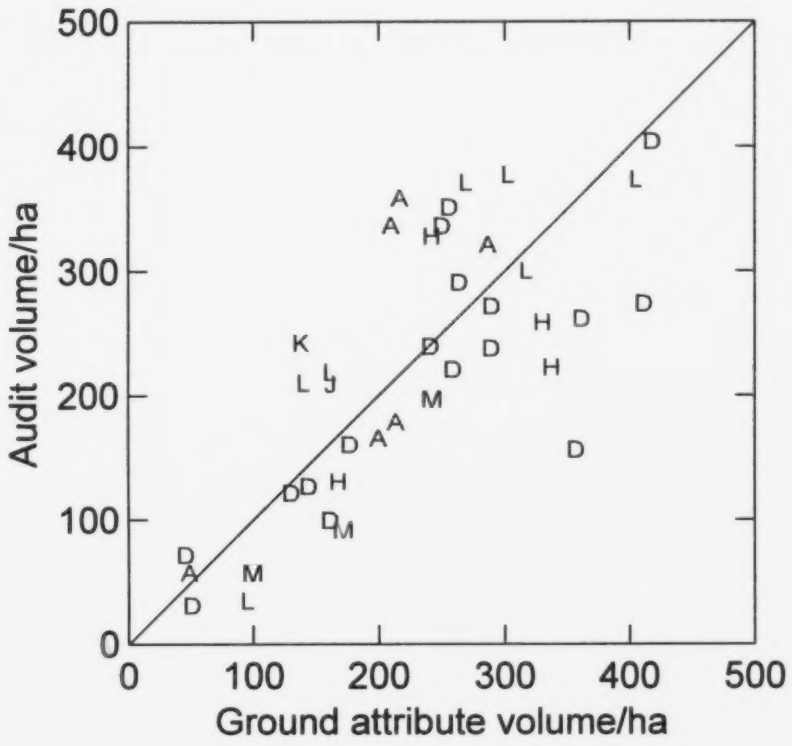
* Top height and hence ground attribute volume was not available for sample #26. All of the statistics on this page are based on the 39 samples for which there were both audit and ground attribute volumes.

TFL 8 Inventory Audit: Audit Volume (Kozak) vs. Ground Attribute Volume (Predicted in VDYP) by GTG

(Tree Class 1 & 2, less decay, 12.5cm+ dbh)



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C	*Fd Pl, Fd Py, Py*	L	*Pl or Pa*
D	*FdL, Pw, LFd, L*	M	*PlFd, PlPy, PlL, PlPw, PlS, PlB, PlH, PlCw, PlYc*
H	*B, BH, BS*		

Ground Attribute Volume (predicted in VDYP) vs. Inventory Volume (predicted in VDYP): *"Attribute" Bias (n=39*)*

1. Average volumes/ha and confidence interval @ 95% *(Utilization level: Tree Class 1,2; net merch. less decay; 12.5cm+ dbh)*

195——227——259 Ground Attribute Volume (14.2% sampling error)

206——236——267 Inventory Volume (13.0% sampling error)

2. Ratio Analysis : Ratio of Means @ 95%

$$R = \frac{\text{average ground attribute volume (VDYP)}}{\text{average inventory volume (VDYP)}} = 0.96$$

1.0
↓
0.86——0.96——1.06

** The ratio indicates there is no significant difference between the ground attribute volume predicted in the VDYP and the inventory volume predicted in the VDYP.*

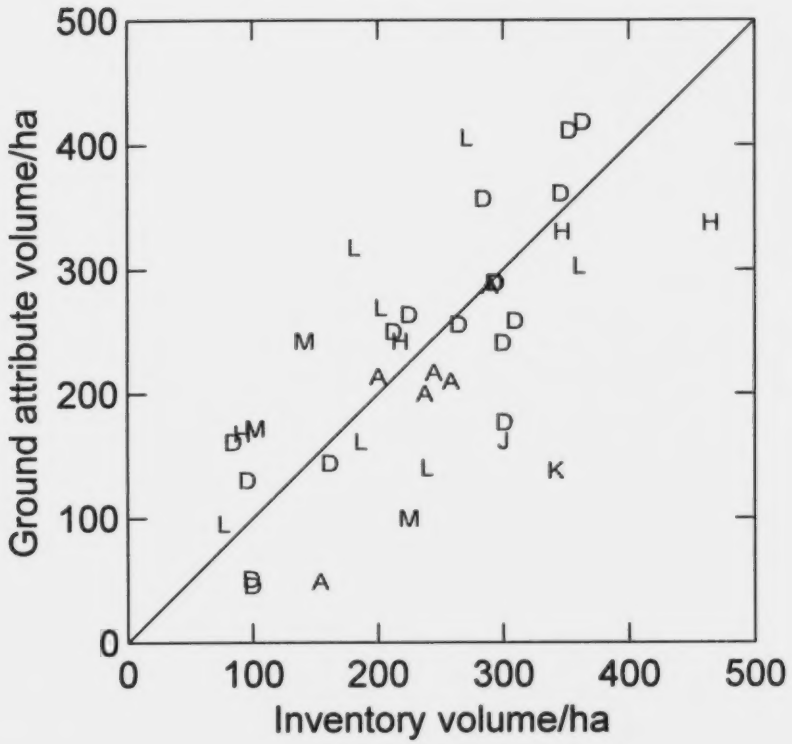
3. Paired T Test @ 95% ($\alpha = 0.05$) for all sample polygons
mean difference = -9.362 m^3/ha
p - value for mean difference = 0.458
**since p - value > α, the difference is not significant*

4. Paired T Test @ 95% for all sample polygons by map label GTG
There were no significant differences within any GTGs.

5. Correlation @95%($\alpha = 0.05$) for all samples
Correlation co-efficient r = 0.678
p - value for correlation co-efficient < 0.001
∴ correlation is significant

* Top height and hence ground attribute volume was not available for sample #26. All of the statistics on this page are based on the 39 samples for which there were both inventory and ground attribute volumes.

TFL 8 Inventory Audit:
Ground Attribute Volume (Predicted in VDYP) vs. Inventory Volume (Predicted in VDYP) by GTG
(Tree Class 1 & 2, less decay, 12.5cm+ dbh)



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D	*FdL, Pw, LFd, L*	M	*PlFd, PlPy, PlL, PlPw, PlS, PlB, PlH, PlCw, PlYc*
H	*B, BH, BS*		

Audit (ground measured) top height vs. Inventory Height (n=39)*

1. Average height (m) and confidence interval @ 95%

21.8——23.7——25.6 Audit (ground measured) height (8.0% sampling error)

22.6——24.4——26.3 Inventory height (7.4% sampling error)

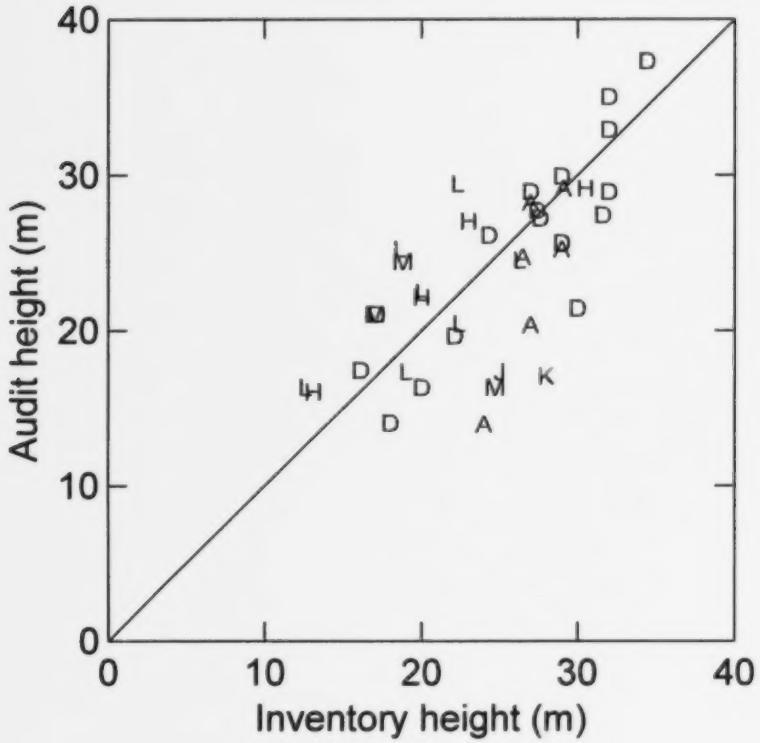
2. Paired T Test @ 95% ($\alpha = 0.05$) for all sample polygons
mean difference = -0.764 m
p - value for mean difference = 0.301
**since p - value > α, the difference is not significant*

3. Paired T Test @ 95% for all sample polygons by map label GTG
There were no significant differences within GTGs.

4. Correlation @95%($\alpha = 0.05$) for all samples
Correlation co-efficient r = 0.687
p - value for correlation co-efficient < 0.001
∴ correlation is significant

* Top height (ie. audit height) was not available for sample #26. All of the statistics on this page are based on the 39 samples for which there were both inventory and audit heights.

TFL 8 Inventory Audit: Audit Height vs. Inventory Height (by GTG)



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D	*FdL, Pw, LFd, L*	M	*PlFd, PlPy, PlL, PlPw, PlS, PlB, PlH, PlCw, PlYc*
H	*B, BH, BS*		

Audit (ground measured) age of top height trees vs. Inventory age (n=39)*

1. Average age (years) and confidence interval @ 95%

108——————**126**——————**144** Audit (ground measured) age (14.2% sampling error)

124——————**142**——————**159** Inventory age (12.4% sampling error)

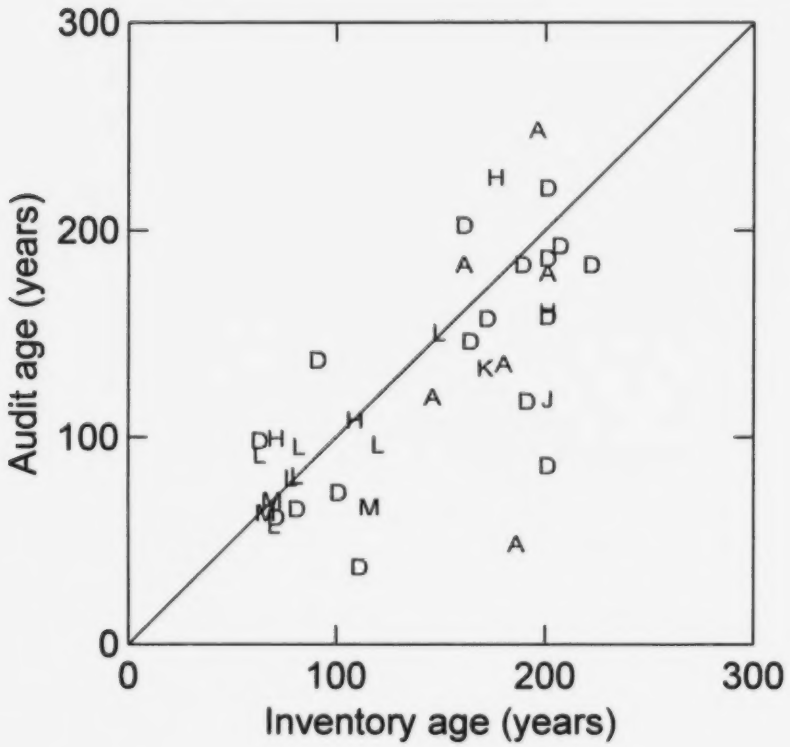
2. Paired T Test @ 95% ($\alpha = 0.05$) for all sample polygons
mean difference = -15.8 years
p - value for mean difference = 0.025
**since p - value < α, the difference is significant*

3. Paired T Test @ 95% for all sample polygons by map label GTG
There were no significant differences within GTGs.

4. Correlation @95%($\alpha = 0.05$) for all samples
Correlation co-efficient r = 0.699
p - value for correlation co-efficient < 0.001
∴ correlation is significant

* Top height (and average age of top height trees) was not available for sample #26. All of the statistics on this page are based on the 39 samples for which there were both inventory and audit ages.

TFL 8 Inventory Audit:
Audit Age vs. Inventory Age (by GTG)



Letter symbols correspond to map label GTG's as follows:

A	*Fd, Fd Decid*	J	*SF, SH (and SC), SB*
B	*FdCw and FdYc, FdH, FdS*	K	*SPl, SDecid*
C	*Fd Pl, Fd Py, Py*	L	*Pl or Pa*
D	*FdL, Pw, LFd, L*	M	*PlFd, PlPy, PlL, PlPw, PlS, PlB, PlH, PlCw, PlYc*
H	*B, BH, BS*		

Audit Volume (Kozak) vs. Analysis Unit Volume (n=35*)

1. Average volumes/ha and confidence interval @ 95% *(Utilization level: Tree Class 1,2; net merch. less DWB; 12.5cm+ dbh for Pl leading, 17.5cm+ dbh for other species leading)*

172 ——— 209 ——— 245 Audit Volume (17.6% sampling error)

196 ——— 224 ——— 252 Analysis Unit Volume (12.4% sampling error)

2. Ratio Analysis : Ratio of Means @ 95%

$$R = \frac{\text{average audit volume (Kozak)}}{\text{average analysis unit volume}} = 0.93$$

1.0
↓

0.78 ——— 0.93 ——— 1.08

** The ratio indicates there is no significant difference between the audit volume and the analysis unit volume.*

3. Paired T Test @ 95% ($\alpha = 0.05$) for all sample polygons
mean difference = -15.337 m^3/ha
p - value for mean difference = 0.360
**since p - value > α, the difference is not significant*

4. Paired T Test @ 95% for all sample polygons by map label GTG
There was a significant difference within GTG M.
(for GTG M: mean difference = -181.6 m^3/ha; p-value = 0.004; n=3)

5. Correlation @95%($\alpha = 0.05$) for all samples
Correlation co-efficient r = 0.486
p - value for correlation co-efficient = 0.003
.: correlation is significant

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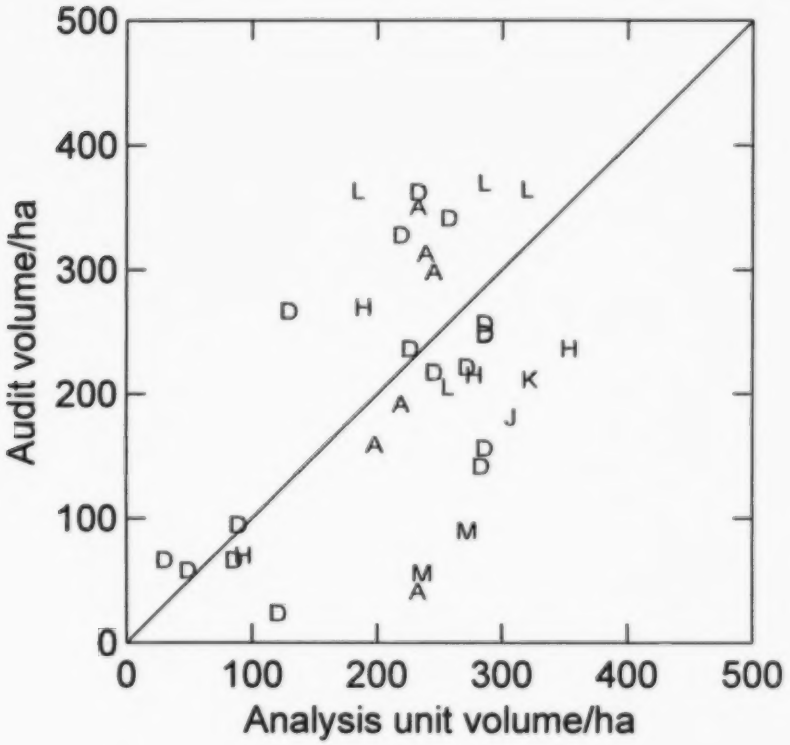
* Analysis unit volumes were provided by Sterling Wood Group. Analysis unit volumes were only available for 35 samples.

TFL 8 Inventory Audit:
Audit Volume (Kozak) vs. Analysis Unit Volume by GTG
(Tree Class 1,2 less DWB, 12.5cm+ dbh for Pl leading, 17.5cm+ dbh for all others)



Letter symbols correspond to map label GTG's as follows:

A	*Fd, Fd Decid*	J	*SF, SH (and SC), SB*
B	*FdCw and FdYc, FdH, FdS*	K	*SPl, SDecid*
C	*Fd Pl, Fd Py, Py*	L	*Pl or Pa*
D	*FdL, Pw, LFd, L*	M	*PlFd, PlPy, PlL, PlPw, PlS, PlB, PlH, PlCw, PlYc*
H	*B, BH, BS*		

Audit Volume (Kozak) vs. Inventory Volume (Predicted in VDYP): OPERABLE Samples (n=35)*

1. Average Volumes/ha and Confidence Interval @ 95% *(Utilization level : Tree Class 1,2; net merch. less decay; 12.5cm+ dbh)*

190——————227——————263 Audit Volume (16.1% sampling error)

215——————247——————279 Inventory Volume (map label attributes predicted in VDYP) (13.0% sampling error)

2. Ratio Analysis : Ratio of Means @95% for operable samples (n=35)

$R = \frac{\text{average audit volume}}{\text{average inventory volume}} = 0.92$

1.0
↓
0.79——————0.92——————1.04

* *Since 1.0 is within the interval, the ratio indicates that there is no significant difference between the audit volume and the inventory volume for operable samples.*

3. Paired T Test @ 95% (α=0.05) for operable sample polygons (n=35)
mean difference = -20.04 m^3/ha
p - value for mean difference = 0.207
**since p-value > α, the difference is not significant*

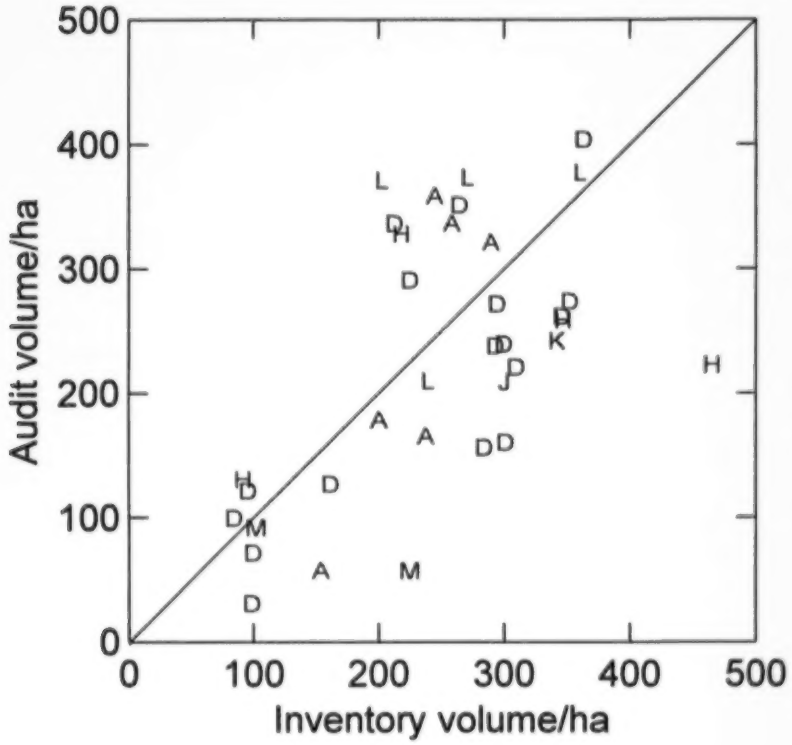
4. Paired T Test @ 95% for operable sample polygons by map label GTG
There were no significant differences within the GTGs.

5. Correlation @ 95% (α=0.05) for operable samples (n=35)
Correlation co-efficient r = 0.580
p-value for correlation co-efficient < 0.001
∴ correlation is significant

---

* Operability was **not** provided by licensee. It was assumed that all samples with an AU volume were operable.

TFL 8 Inventory Audit:
Audit Volume vs. Inventory Volume (by GTG)
for OPERABLE SAMPLES (n=35)
(Tree Class 1 & 2, less decay, 12.5cm+ dbh)



Letter symbols correspond to map label GTG's as follows:

A	*Fd, Fd Decid*	J	*SF, SH (and SC), SB*
B	*FdCw and FdYc, FdH, FdS*	K	*SPl, SDecid*
C	*Fd Pl, Fd Py, Py*	L	*Pl or Pa*
D	*FdL, Pw, LFd, L*	M	*PlFd, PlPy, PlL, PlPw, PlS, PlB, PlH, PlCw, PlYc*
H	*B, BH, BS*		

Audit volume (Kozak, plots outside polygon excluded) vs. Inventory Volume (predicted in VDYP) (n=40)

1. Average Volumes/ha and Confidence Interval @ 95% *(Utilization level : Tree Class 1,2; net merch. less decay; 12.5cm+ dbh)*

185——220——255 Audit Volume (15.9% sampling error)

199——231——263 Inventory Volume (map label attributes predicted in VDYP) (13.8% sampling error)

2. Ratio Analysis : Ratio of Means @95%

$$R = \frac{\text{average audit volume}}{\text{average inventory volume}} = 0.95$$

1.0
↓

0.83——0.95——1.08

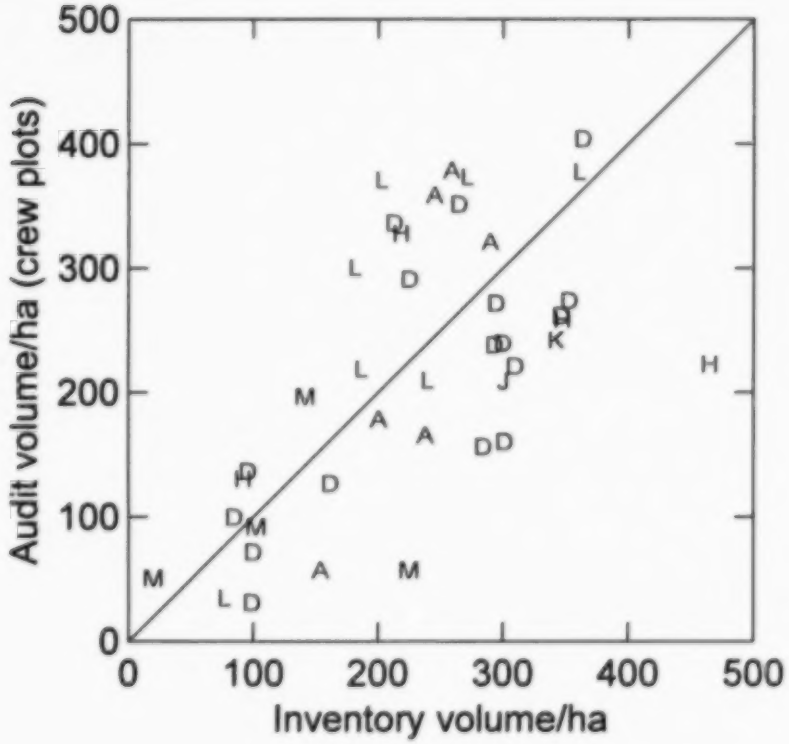
• *Since 1.0 is within the interval, the ratio indicates that there is no significant difference between the audit volume (Kozak, plots outside polygon excluded) and the inventory volume.*

3. Paired T Test @ 95% (α=0.05) for all sample polygons
mean difference = -11.255 m^3/ha
p - value for mean difference = 0.442
**since p-value > α, the difference is not significant*

4. Paired T Test @ 95% for all sample polygons by map label GTG
There were no significant differences within any of the GTGs.

5. Correlation @ 95% (α=0.05) for all samples
Correlation co-efficient r = 0.617
p-value for correlation co-efficient < 0.001
.: correlation is significant

TFL 8 Inventory Audit:
Audit volume (Kozak, plots outside of polygon excluded) vs. Inventory Volume (Predicted in VDYP) by GTG
(Tree Class 1 & 2, less decay, 12.5cm+ dbh)



Letter symbols correspond to map label GTG's as follows:

A	*Fd, Fd Decid*	J	*SF, SH (and SC), SB*
B	*FdCw and FdYc, FdH, FdS*	K	*SPl, SDecid*
C	*Fd Pl, Fd Py, Py*	L	*Pl or Pa*
D	*FdL, Pw, LFd, L*	M	*PlFd, PlPy, PlL, PlPw, PlS, PlB, PlH, PlCw, PlYc*
H	*B, BH, BS*		

Inventory Classification Assessment

- **45%** of the growth type groups* from the inventory (ie. map labels) matched the audit growth type groups.
- the growth type group distribution for the 40 inventory audit samples is as follows (the bold italic entries on the diagonal in the table indicate a GTG match between the audit and the inventory):

Audit GTG	***Inventory GTG***									
	A	B	C	D	H	J	K	L	M	*total*
A	***3***	0	0	5	0	0	0	0	0	8
B	0	***0***	0	2	0	0	0	1	0	3
C	0	0	***0***	1	0	0	0	0	1	2
D	1	0	0	***3***	0	0	0	0	1	10
H	0	0	0	0	***2***	1	0	0	0	3
J	1	0	0	0	1	***0***	1	0	0	3
K	0	0	0	0	1	0	***0***	1	0	2
L	0	0	0	0	0	0	0	***4***	1	5
M	1	0	0	1	0	0	0	1	***1***	4
total	6	0	0	17	4	1	1	7	4	**40**

Letter symbols correspond to GTG's as follows:

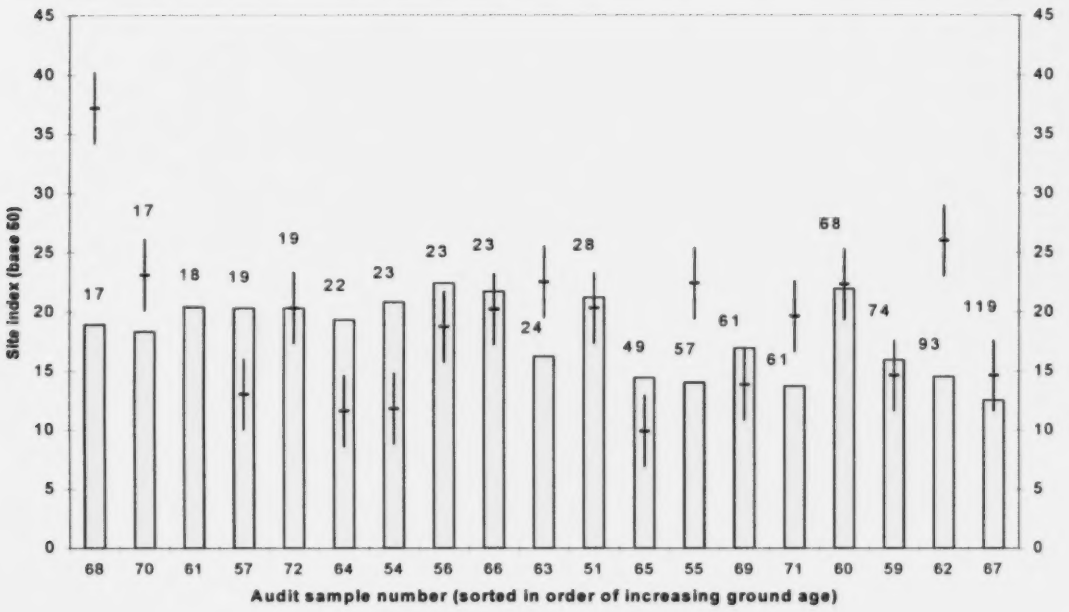
A	*Fd, Fd Decid*	J	*SF, SH (and SC), SB*
B	*FdCw and FdYc, FdH, FdS*	K	*SPl, SDecid*
C	*Fd Pl, Fd Py, Py*	L	*Pl or Pa*
D	*FdL, Pw, LFd, L*	M	*PlFd, PlPy, PlL, PlPw, PlS, PlB, PlH, PlCw, PlYc*
H	*B, BH, BS*		

** As generated by VDYP.*

Immature Site Index and Classification Assessment

- **50%** of the growth type group assignments from the inventory (ie. map labels) matched the corresponding audit growth type group assignment.

TFL 8 Inventory Audit:
Comparison of Inventory and Audit Site Index for Immature Samples



Notes:

- shaded bars correspond to ***audit site index*** values
- tick marks on vertical lines represent ***inventory site index*** (vertical lines have arbitrarily been set at ±3m around site index)
- inventory site index values generated in Site Tool
- audit site index values generated in SiteTools (based on BH age as available)
- numbers above bars correspond to ground age (ie. audit age)
- inventory SI was not available for 1 sample (no SI from Sitetool if ht <2m)
- no suitable TH trees for 1 audit sample
- of the 18 samples for which SIs were compared, 6 inventory SIs were within 3m of the audit SI; 6 were > 3m lower than the audit SI, and 6 were > 3m higher